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FEDERAL COMMUNICATIONS COMMISSION
INTERNATIONAL BUREAU

Satellite and Radiocommunication Division
Satellite Policy Branch

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To: Mr. William F. Caton, Acting Secretary

Date: January 29, 1996

From: Jennifer M. Gilsenan

Re: Ex parte presentation
CC Docket No. 92-297

RECEIVED

JAN 29 1996

FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

This will serve to indicate that on January 25, 1996 representatives of the International Bureau, Office of Plans and Policy, and the Wireless Telecommunications Bureau met with the participants listed in Attachment A to this memorandum to discuss 28 GHz band plan options. The attached documents formed a basis for discussion.

Cover

1/25/96

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Band Plan Options for the 28 GHz Band

Option 1: Band plan proposed in the Third NPRM.

LMDS fss	GSO/FSS ngso/fss	NGSO/FSS gso/fss	MSS FEEDER LINKS & LMDS [H→S]	MSS FEEDER LINKS & GSO/FSS	GSO/FSS ngso/fss
850 MHz	250 MHz	500 MHz	150 MHz	250 MHz	500 MHz

27.5 28.35 28.6 29.1 29.25 29.5 30.0 GHz

- LMDS subscriber transceivers would not be able to transmit in the band shared with feeder links.
- TRW would operate on a reverse band basis. Sharing criteria necessary between feeder links for the 2 MSS systems at 19 GHz.
- First come first served protection in the 29.25-29.5 band segment.

Option 2: More Extensive Sharing Requirements

LMDS fss	GSO/FSS ngso/fss	WRC-97	NGSO/FSS gso/fss	TRW, Motorola, & LMDS [S↔H]	TRW, Motorola & GSO/FSS	GSO/FSS ngso/fss
850 MHz	250 MHz		400 MHz	150 MHz	250 MHz	500 MHz

27.5 28.35 28.6 28.7 29.1 29.25 29.5 30.0 GHz

- Rules for sharing between Motorola and LMDS so that LMDS can transmit from subscriber to hubs in the shared portion of the bands. (See Attached).
- Rules for sharing between TRW and Motorola i.e., geographical separation of gateway earth stations at distances to be determined by the FCC between approximately 200 and 800 kilometers.
- Rules for sharing between 2 MSS feeder link systems and GSO systems.

Option 3: Staff Band Segmentation Adjustment

LMDS fss 850 MHz	GSO/FSS ngso/fss 250 MHz	W R C - 9 7	NGSO/FSS gso/fss 400 MHz	Motorola & TRW 150 MHz	TRW & LMDS [S↔H] 125 MHz	GSO/FSS ngso/fss 625 MHz

27.5 28.35 28.6 28.7 29.1 29.25 29.375 30.0GHz

- 40 kilometer coordination zone around 2 U.S. TRW sites. In this zone, LMDS accepts interference or undertakes mitigation efforts consistent with TI's proposal for subscriber to hub operations.
- Sharing criteria for Motorola and TRW (Same as Option 2).

Tentative Draft Staff Recommendation

§101. LMDS subscriber transceivers transmitting in the 29.1-29.25 GHz Band

1) LMDS subscriber transceivers operating in the 29.1-29.25 GHz band:

a) shall operate at a peak EIRP per carrier of 12 dBW/MHz in clear air, and shall reduce its EIRP at distances less than the maximum distance from the hub at which a subscriber transceiver is located in accordance with the following formula:

EIRP(dBW/MHz)= 12 dBW/MHz + 20 log d/D

where d = transceiver distance to hub
D = maximum transceiver distance to hub

the peak EIRP derived from this formula may be exceeded in cases where link propagation attenuation exceeds the clear air value and only to the extent that the link is impaired plus a 1 dB margin.

b) shall not exceed the relative peak antenna gain described in Figure X .

See Attached Figure X

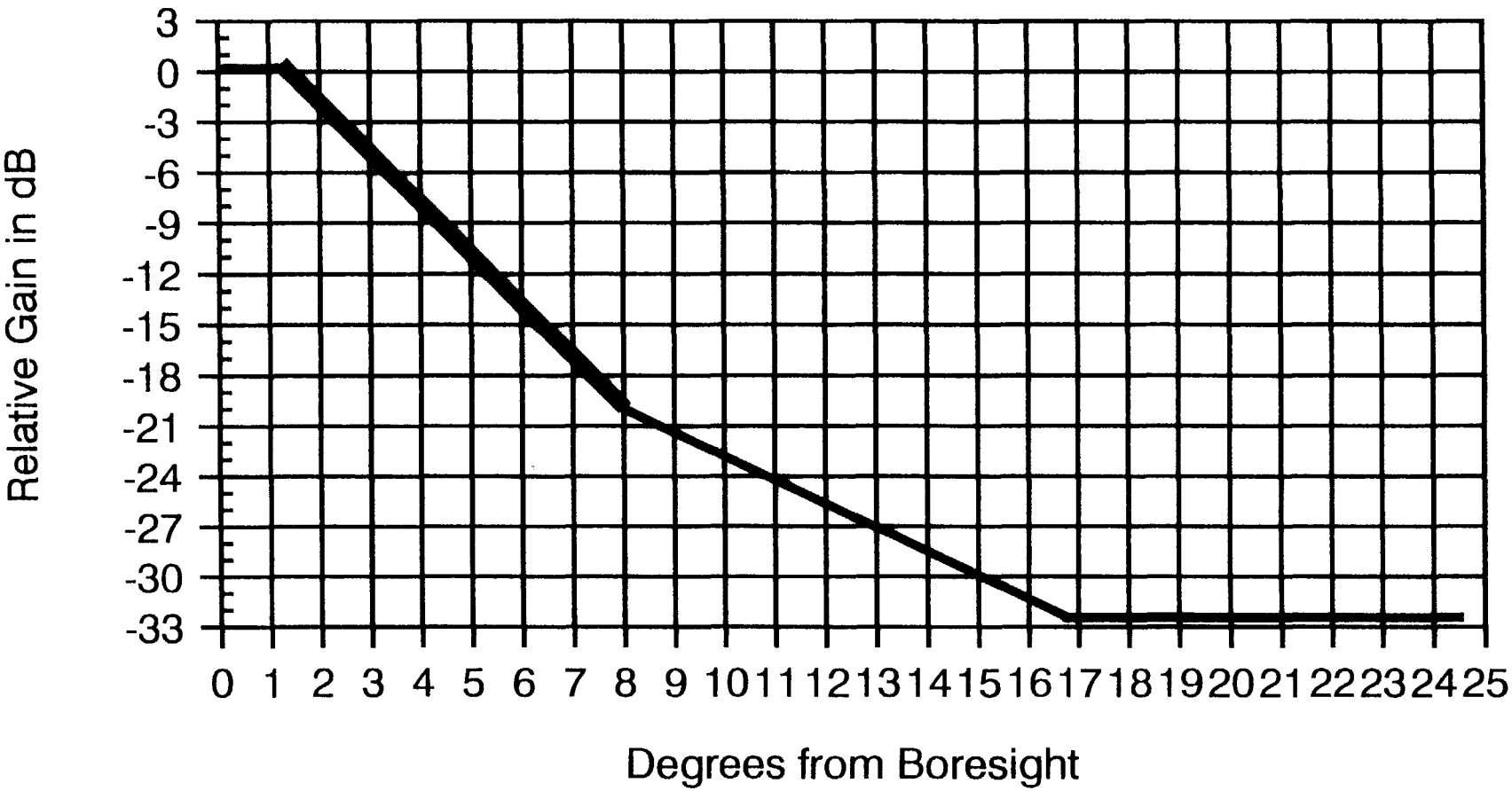
c) each CPE shall automatically inhibit its transmissions if it is not receiving a signalling / communication channel from its associated hub.

LMDS hub stations receiving in the 29.1-29.25 GHz Band:

a) shall be capable of providing automatic power control to LMDS subscriber transceivers to ensure that the EIRP defined in Section X Part (a) is not exceeded by more than 1 dB.

CPE Antenna Mask

Elevation and Azimuth



Spaceway Capacity Issues

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- Single satellite can carry processor for 500 MHz (next year's technology)
- Business risk reduction dictates on-orbit redundant satellite (standard GSO practice)
  - Another 500 MHz needed
- 4-cell frequency re-use pattern maximizes spectral efficiency
  - Divide 500 MHz by 4 = 125 MHz/beam
- Spectrum needs are 4 x 125 MHz on each of two satellites
- Beams are not divisible
  - Single carrier in each beam
- Segments of allocated spectrum must consist of multiple of beam size
  - e.g., multiples of 125 MHz

Low Cost Opens Mass Market for SPACEWAY™

HUGHES COMMUNICATIONS

Low-cost SPACEWAY™ terminal depends on 1 GHz of spectrum

- Supports more than 1 million user terminals
  - Manufacturing volume drives down cost of terminal
  - Necessary for $ 1000 mass-market terminal in business case

Low-cost SPACEWAY™ service depends on large capacity => frequency re-use

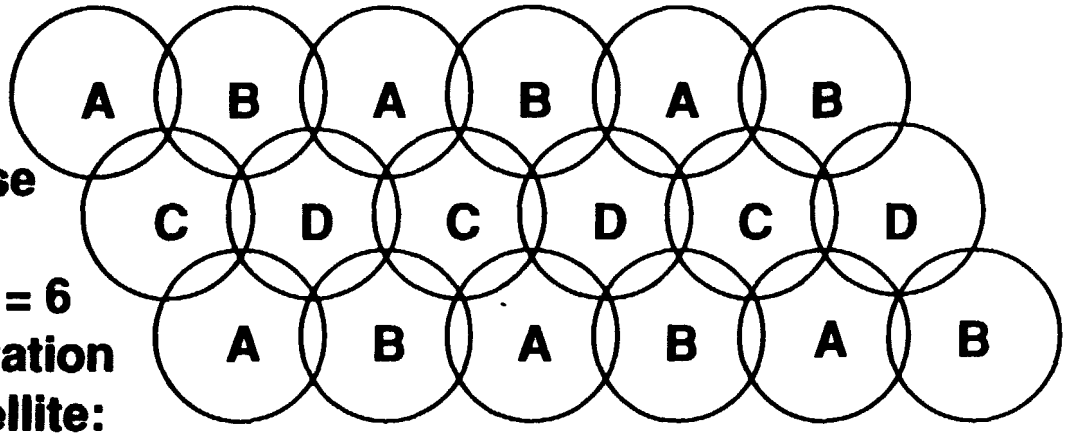
- Large capacity shared among many users gives low cost of usage
- Re-use provides capacity for more than 1 million users in business case
  - 125 MHz frequency re-use cell in spot beam pattern
  - 6 x spatial, 2 x polarization = 12 x frequency re-use

SPACEWAY™ Frequency Plan & Re-use

HUGHES COMMUNICATIONS

- 24 footprints per satellite
- 2 beams per footprint
- 4 footprints per frequency reuse cluster
- Spatial frequency reuse = 24/4 = 6
- 500 Mhz per cluster per polarization
- Total usable spectrum per satellite:
  => 500 Mhz x 6 x 2 = 6 GHz

Beam Lay-down Example



Satellite Allocation Plan (500 Mhz per satellite)

Uplink frequency [GHz] / Downlink frequency [GHz]	29.500 - 29.625 / 19.700 - 19.825		29.625 - 29.750 / 19.825 - 19.950		29.750 - 29.875 / 19.950 - 20.075		29.875 - 30.000 / 20.075 - 20.200	
Polarization	L	R	L	R	L	R	L	R
Beam family	A	B	B	C	C	D	D	A

3-CELL RE-USE PATTERN

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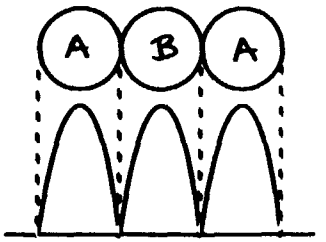
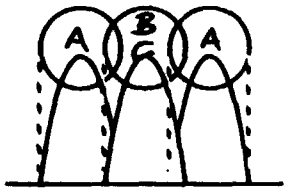
Baseline 4-cell re-use pattern

- Same frequency is spatially separated one beamwidth
- Steep antenna rolloff gives adequate isolation



3-cell re-use pattern

- Same frequency is spatially separated by 0.87 beamwidth
- Steep antenna rolloff means much larger interference
- Co-channel interference (CCI) increases 5 dB or more



Unacceptable loss of capacity or performance

Uplink Interference at Ka-Band from MSS Feeder Links (Odyssey) into GSO FSS Systems

Dr. Richard Barnett
TELECOMM STRATEGIES for Lockheed Martin
January 25, 1996

Interference Analysis

- Uplink only
- Worst case (no mitigating factors)
- Independent of TRW analysis (simulation software)
- Results relevant to small or large user terminals in the GSO FSS system
- Compares interference against CPM criteria
- Discusses outages versus interference
- Includes comparison with sun outage events
- Concludes sharing is feasible

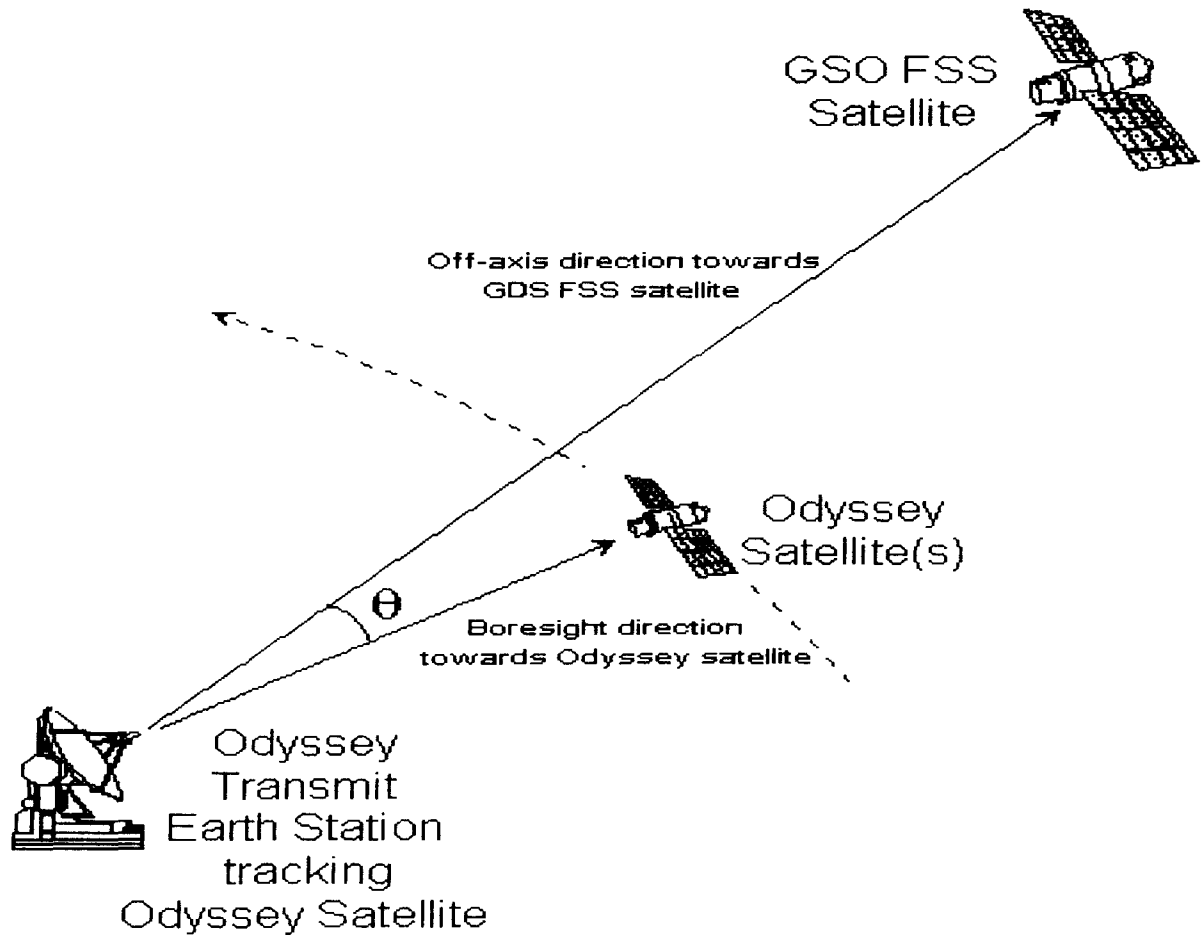
Assumptions (1)

- Worst case:
  - co-frequency (full frequency overlap)
  - co-polar (both operating in LHCP)
  - co-coverage (GSO receive beam peak at Odyssey earth station)
  - fully loaded Odyssey system (peak spectral density - CDMA)
- I_0/N_0 criteria:
  - CPM Report 95/118 (although not an ITU-R Rec.)
- Interferer as defined by TRW:
  - transmit power density (peak) = -55.49 dBW/Hz
  - transmit earth station gain (peak) = +64.8 dBi
  - off-axis gain envelope < 29-25 log(theta) dBi

Assumptions (2)

- GSO satellite receive characteristics:
  - peak antenna gain = 43.4 dBi (approximately 1° diameter)
  - system noise temperature = 600K (i.e., +27.8 dB-K)
  - gives G/T = +15.6 dB/K
- Above beam is compatible with the use of 65 cm user terminals
- Receive antenna beam peak pointing towards Odyssey uplink earth station location

Uplink Interference Geometry



$\theta = 0$

In-Line Interference Analysis

Interfering power density into uplink antenna	-55.49 dBW/Hz
Peak gain of uplink antenna	+64.8 dBi
Peak interfering EIRP spectral density	+9.31 dBW/Hz
Space loss	-213.5 dB
GSO satellite peak gain	+43.4 dB
GSO received interfering power density (I_0)	-160.79 dBW/Hz
GSO satellite noise temperature	+27.8 dBK (600K)
Boltzmann's constant	-228.6 dB
GSO receive noise power density (N_0)	-200.8 dBW/Hz
GSO receive I_0/N_0	+40.01 dB

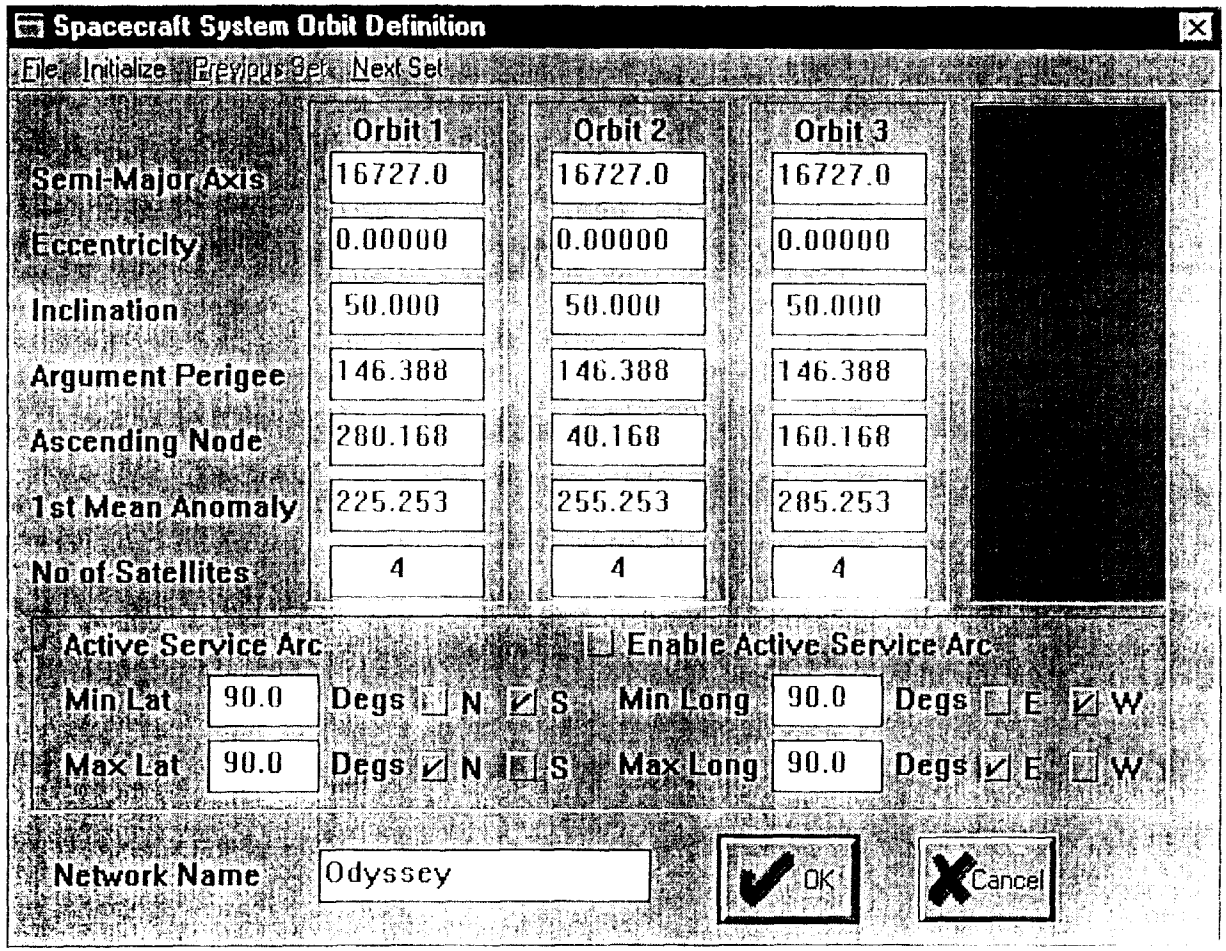
Interference Threshold Off-Axis Angle

CPM criteria (95/118)			Computed isolation requirements for interference threshold	
% time not to be exceeded	I_0/N_0 (linear)	I_0/N_0 (dB)	Off-axis isolation	Off-axis angle $29-25\log(\theta)$
0.87	0.06	-12.22	52.23 dB	4.54°
0.119	0.78	-1.08	41.09 dB	1.63°
0.0294	2.98	+4.74	35.27 dB	0.95°
0.0004	14.8	+11.70	28.31 dB	0.50°

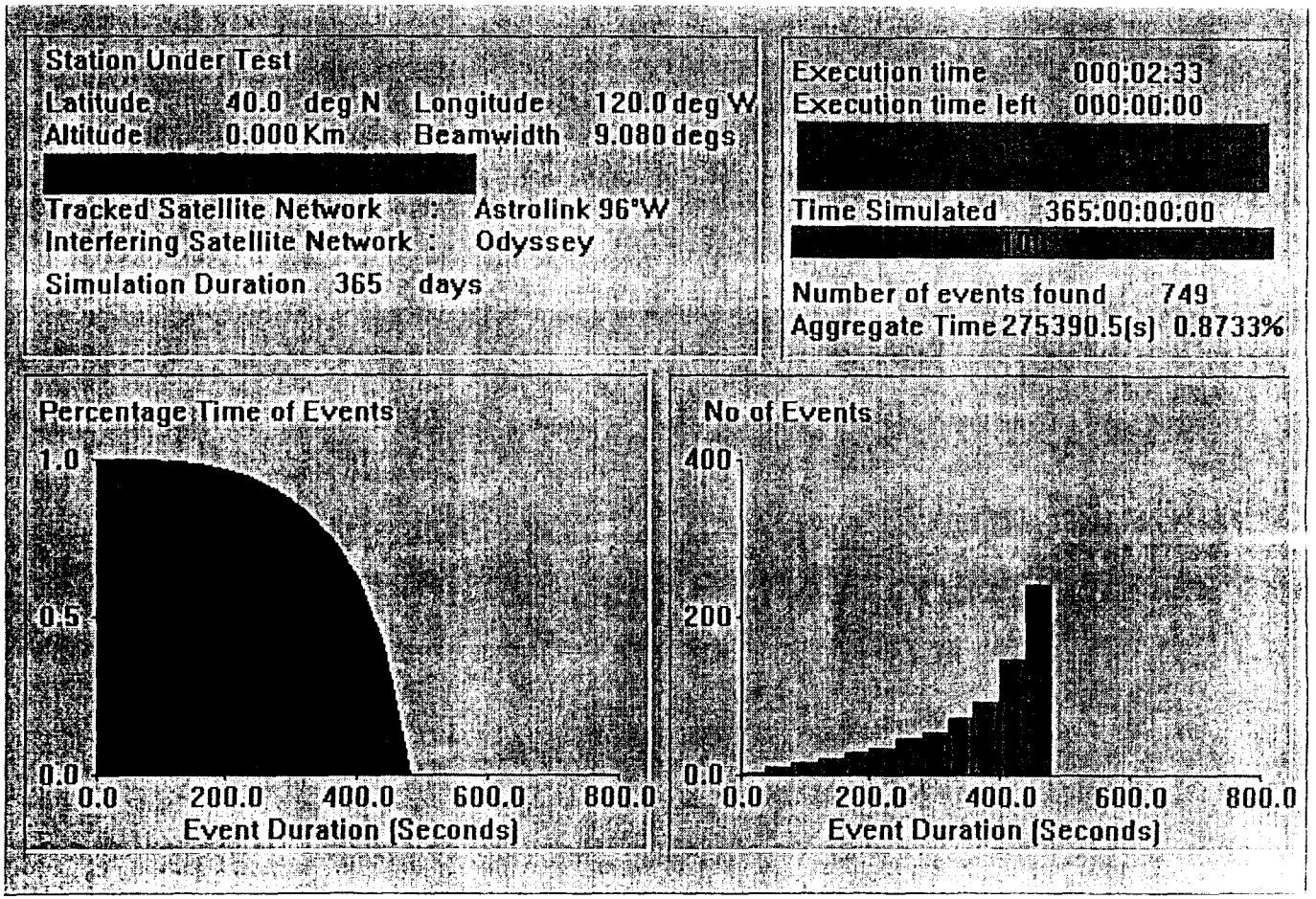
Simulation Software

- Performs time-step simulation of the evolving orbits (NGSO-GSO and NGSO-NGSO)
- Define interference threshold beamwidth (cone angle) of the interfering earth station, and its earth location
- Adaptive algorithm allows long simulated time period with short run-time (365 days in ~2 minutes)
- Counts and aggregates interference events, including duration of each event.
- Provides graphical and numerical output

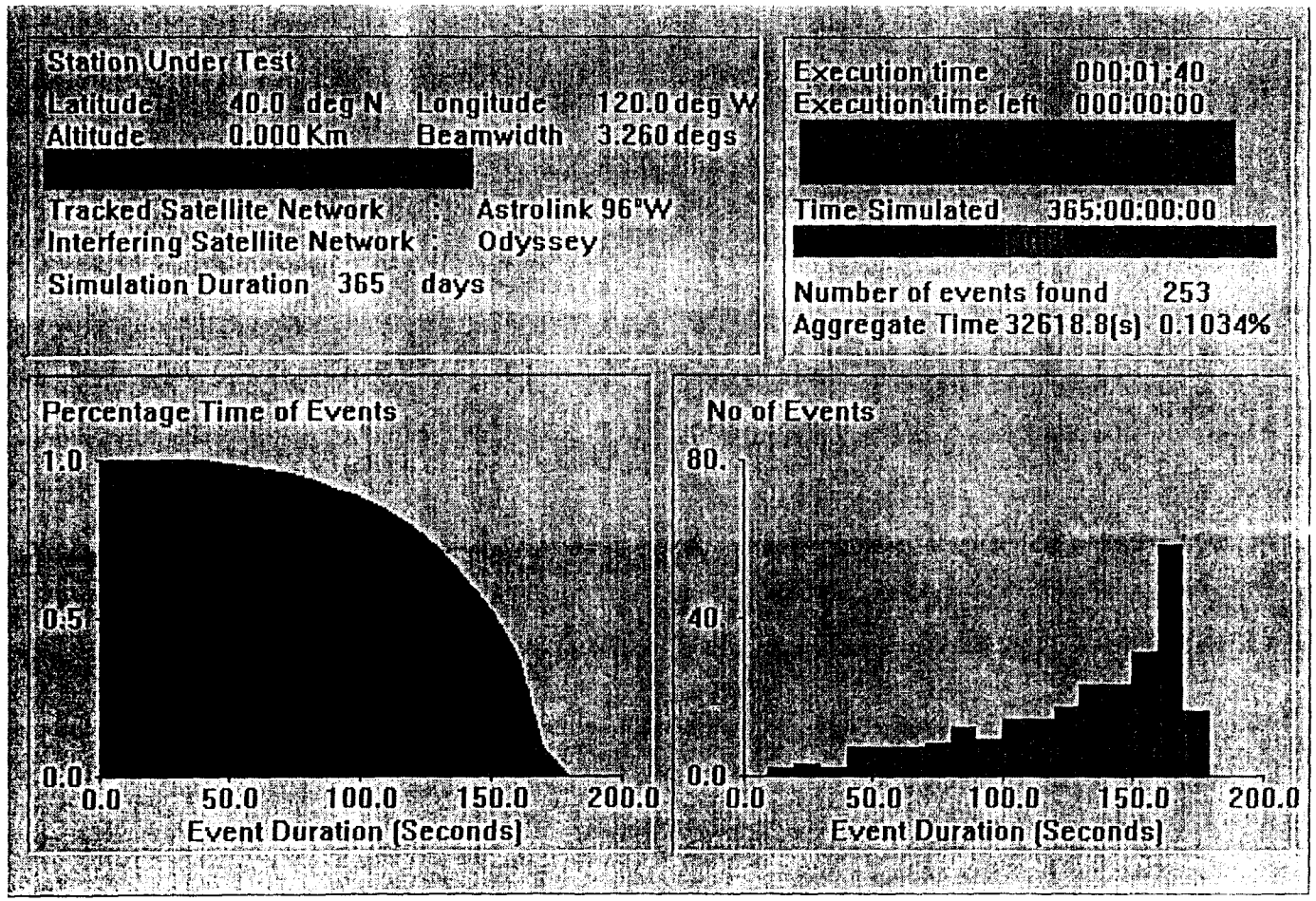
Odyssey Constellation Definition



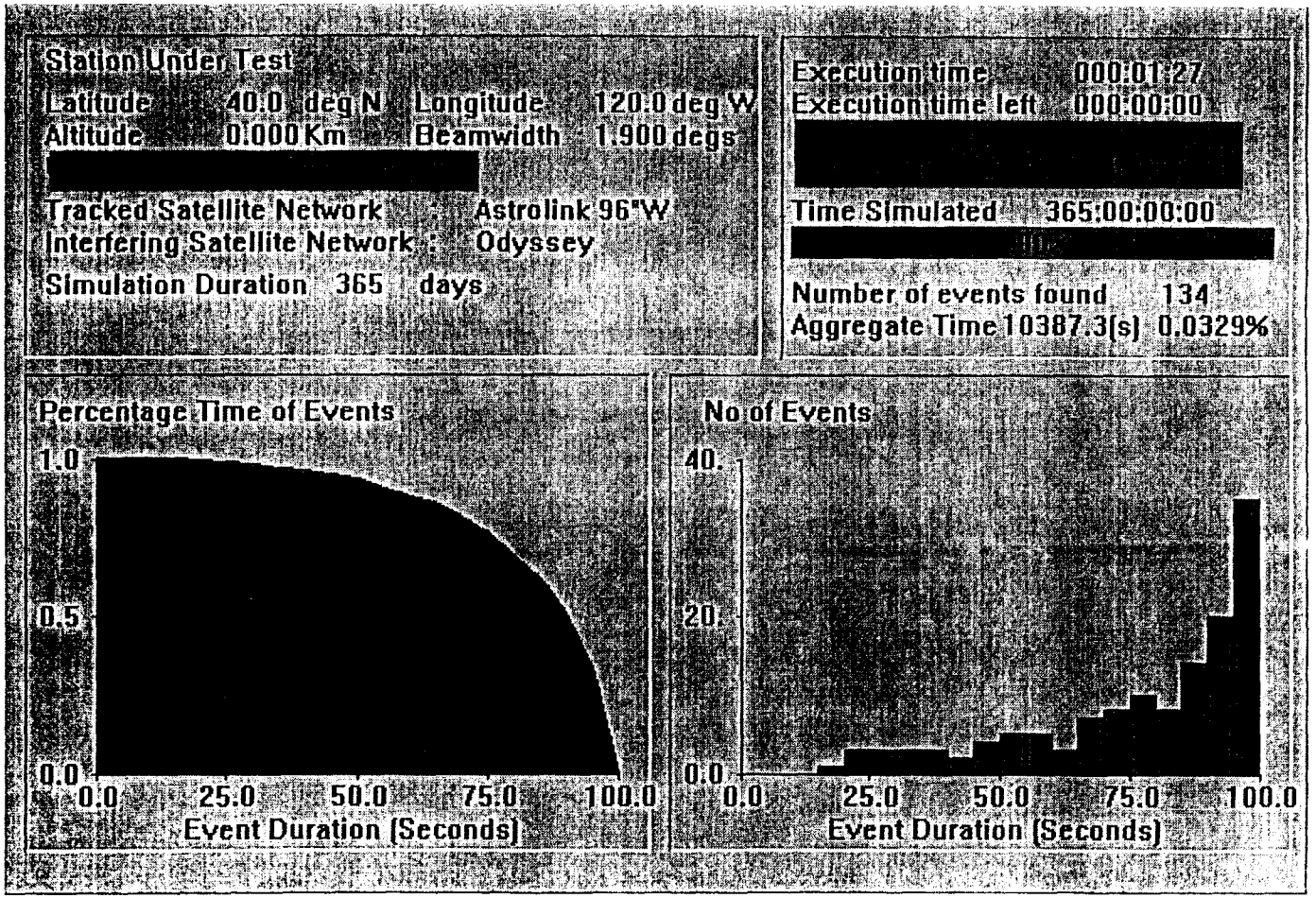
Simulation Results ($I_0/N_0 = 0.06$)



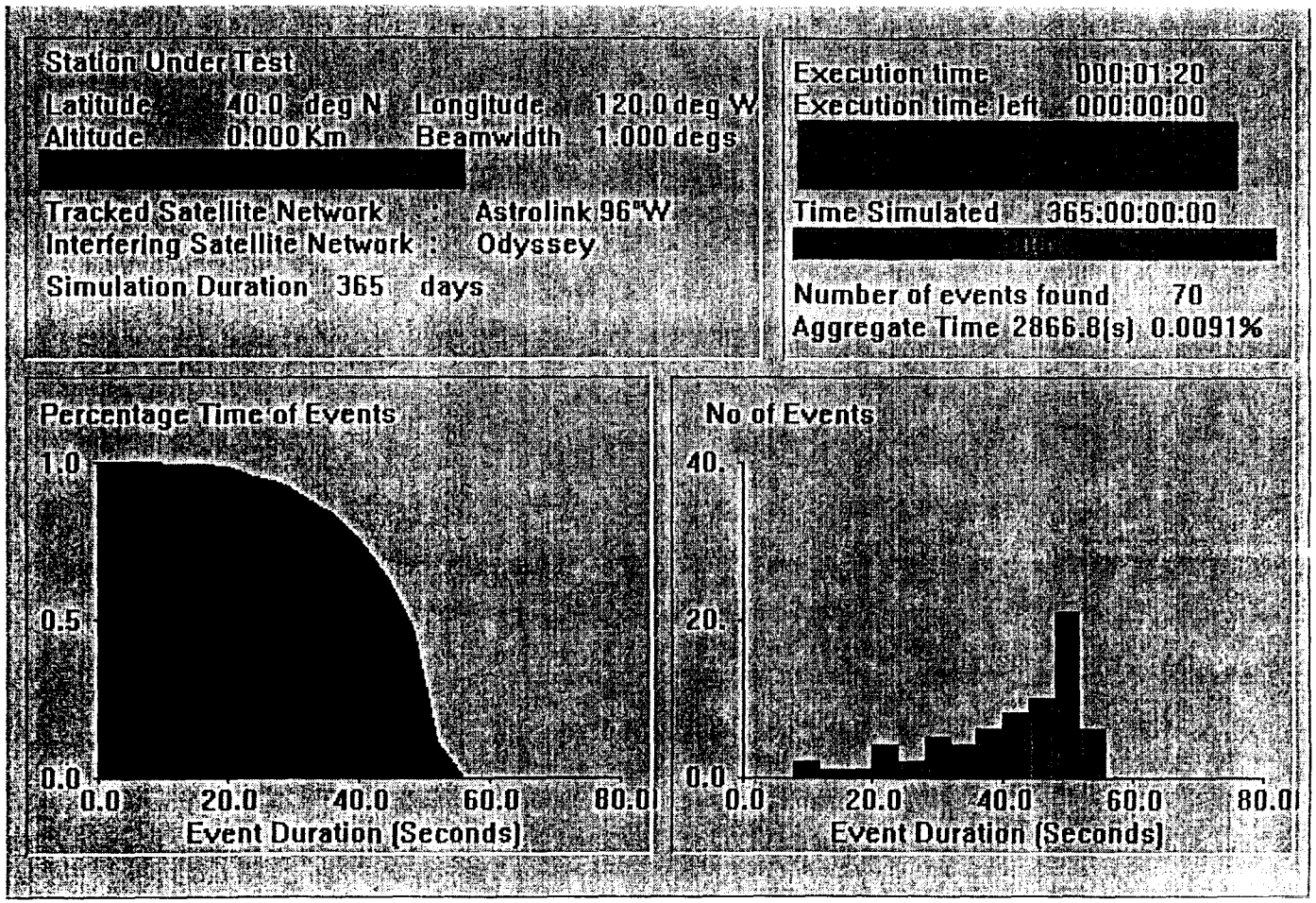
Simulation Results ($I_0/N_0 = 0.78$)



Simulation Results ($I_0/N_0 = 2.98$)



Simulation Results ($I_0/N_0 = 14.8$)



Summary of Results

CPM criteria (95/118)			Simulation Results	
% time not to be exceeded	I_0/N_0 (linear)	I_0/N_0 (dB)	% time occurred	Δ relative to criteria
0.87	0.06	-12.22	0.8733	+0.0033%
0.119	0.78	-1.08	0.1034	-0.0156%
0.0294	2.98	+4.74	0.0329	+0.0035%
0.0004	14.8	+11.70	0.0091	+0.0087%